CLAIMS

What is claimed is:

1. A method, comprising:

imaging a plurality of markers in a first imaging modality, the plurality of markers residing internal to a body;

determining first coordinates of the plurality of markers relative to a first beam isocenter;

imaging the plurality of markers in a second imaging modality; and

determining second coordinates of the plurality of markers relative to a second beam isocenter.

2. The method of claim 1, wherein the first beam isocenter is a planned treatment beam isocenter and the second beam isocenter is a treatment machine beam isocenter at a time of treatment.

3. The method of claim 2, further comprising:

correlating the second coordinates with the first coordinates; and

calculating an offset between the first coordinates and the second coordinates for at least one of the plurality of markers.

4. The method of claim 2, wherein the first imaging modality is CT and the second imaging modality is one of KV and MV imaging.

5. The method of claim 3, further comprising adjusting a position of the plurality of markers based on the calculated offset.

6. The method of claim 1, further comprising identifying one or more of the plurality of markers that are imaged in the second imaging modality.

7. The method of claim 6, wherein imaging the plurality of markers in the first imaging modality generates a first image and imaging the plurality of markers in the second imaging modality generates a second image.

8. The method of claim 7, wherein identify one or more of the plurality of markers that are imaged in the second imaging modality comprises performing a 2D size and shape consistency test of a region of interest of the second image.

9. The method of claim 8, wherein the 2D size and shape consistency test comprises median filtering and connected component analysis.

10. The method of claim 8, wherein identify one or more of the plurality of markers that are imaged in the second imaging modality comprises performing a 3D geometric consistency test of the region of interest of the second image.

11. The method of claim 11, wherein the 3D geometric consistency test comprises an epipolar coincidence constraint.

12. The method of claim 6, identifying one or more of the plurality of markers includes falsely identifying one or more of the plurality of markers and wherein the method further comprises removing the one or more falsely identified markers.

13. The method of claim 6, further comprising determining a position of one or more of the plurality of markers that are not imaged in the second imaging modality.

14. The method of claim 13, wherein the position is determined based on the relationship between the first coordinates and the second coordinates of the one or more of the plurality of markers that are imaged.

15. The method of claim 14, determining the position comprises:

estimating a rigid body transform; and

applying the rigid body transform to the first coordinates to estimate the position of the one or more of the plurality of markers not imaged in the second imaging modality.

16. The method of claim 13, wherein the position is determined manually by a user.

17. A method, comprising:

providing a body having a plurality of internal markers; and

adjusting a position of a target volume within the body relative to a treatment beam using the plurality of internal markers.

18. The method of claim 17, wherein adjusting comprises determining a positional offset between the plurality of internal markers imaged in a first imaging modality and the plurality of internal markers imaged in a second imaging modality.

19. The method of claim 17, further comprising implanting the plurality of internal markers.

20. The method of claim 17, wherein determining the positional offset comprises:

correlating first coordinates of the plurality of internal markers imaged in a first imaging modality with second coordinates of the plurality of internal markers imaged in a second imaging modality; and

calculating a difference between the first coordinates and the second coordinates for at least one of the plurality of markers.

21. A method, comprising:

providing an image containing a marker; and

filtering the image using a median filter.

22. The method of claim 21, wherein filtering comprises taking median intensity values of perimeter pixels around a center pixel being evaluated and subtracting the median intensity values from the center pixel to generate a filtered output pixel intensity value.

23. The method of claim 22, wherein the perimeter pixels are pixels on a perimeter of an approximate circle around the center pixel.

24. The method of claim 23, wherein the perimeter pixels are pixels on a perimeter of an approximate circle around the center pixel.

25. The method of claim 24, wherein the radius of the approximate circle is greater than a width of the marker.

26. A machine readable medium having stored thereon instructions, which when executed by a processor, cause the processor to perform the following comprising:

receiving signals corresponding to pixel intensities of an image containing a marker; and

filtering the image using a median filter.

27. The machine readable medium of claim 26, wherein filtering comprises taking median intensity values of perimeter pixels around a center pixel being evaluated and subtracting the median intensity values from the center pixel to generate a filtered output pixel intensity value.

28. A machine readable medium having stored thereon instructions, which when executed by a processor, cause the processor to perform the following comprising:

performing a 2D size and shape consistency test of a region of interest of an image; and

performing a 3D geometric consistency test of the region of interest to identify one or more of a plurality of markers in the image.

29. The machine readable medium of claim 28, wherein the 3D geometric consistency test comprises an epipolar coincidence constraint.

30. The machine readable medium of claim 28, wherein the processor further performs the following comprising determining a position of one or more of the plurality of markers that are not visible in the image.

31. A method, comprising:

imaging one or more of a plurality of internal markers in a target volume of a body to generate an image, the target volume comprising a target; and

estimating an adjustment to at least one of the body and a treatment beam in, a treatment session, based on a rigidity of the target and a number of visible markers in the image.

32. The method of claim 31, further comprising estimating a number of positioning images needed for the treatment session based on the rigidity of the target and the number of visible markers in the image.

33. The method of claim 31, further comprising implanting the plurality of markers.

34. The method of claim 31, wherein the target is rigid and the number of visible markers is at least one.

35. The method of claim 34, wherein the adjustment is a patient position adjustment.

36. The method of claim 34, wherein the adjustment is a MLC position adjustment.

37. The method of claim 31, wherein the target is rigid and the number of visible markers is at least two.

38. The method of claim 37, wherein the adjustment is a patient orientation adjustment.

39. The method of claim 37, wherein the adjustment is a MLC rotation adjustment.

40. The method of claim 31, wherein the target is deformable and the number of visible markers is three or more.

41. The method of claim 40, wherein the adjustment is a MLC shape.

42. A method, comprising:

imaging one or more of a plurality of internal markers in a target volume of a body to generate an image, the target volume comprising a target; and

estimating a number of positioning images needed for a treatment session based on a rigidity of the target and a number of visible markers in the image.

43. The method of claim 42, wherein the target is rigid and the number of visible markers is at least one.

44. The method of claim 43, wherein the number of positioning images is one.

45. The method of claim 42, wherein the positioning image is from a same angle as a treatment beam angle.

45. The method of claim 32, wherein the target is rigid and the number of visible markers is three or more, and wherein the number of positioning images is two or more from different angles suitable for triangulation.

46. The method of claim 32, wherein the target is deformable and the number of visible markers is three or more, and wherein the number of positioning images is at least one from a same angle as a treatment beam angle.

47. The method of claim 32, wherein the target is deformable and the number of visible markers is three or more, and wherein the number of positioning images is two or more from different angles suitable for triangulation.

48. An apparatus, comprising:

means for imaging a plurality of markers in a first imaging modality, the plurality of markers residing internal to a body;

means for determining first coordinates of the plurality of markers relative to a first beam isocenter;

means for imaging the plurality of markers in a second imaging modality; and

means for determining second coordinates of the plurality of markers relative to a second beam isocenter

49. The apparatus of claim 48, wherein the first beam isocenter is a planned treatment beam isocenter and the second beam isocenter is a treatment machine beam isocenter at a time of treatment.

50. The apparatus of claim 49, further comprising:

means for correlating the second coordinates with the first coordinates; and

means for calculating an offset between the first coordinates and the second coordinates for at least one of the plurality of markers.

51. The apparatus of claim 50, further comprising means for adjusting a position of the plurality of markers based on the calculated offset.

52. The apparatus of claim 48, further comprising means for identifying one or more of the plurality of markers that are imaged in the second imaging modality.

53. A system, comprising:

a first beam source to generate an imaging beam having a first beam isocenter;

a second beam source to generate a treatment beam having a second beam isocenter;

a first imager coupled to receive the imaging beam, the first imager to image a plurality of markers, residing internal to a body, in a first imaging modality;

a second imager coupled to receive the treatment beam, the second imager to image the plurality of markers in a second imaging modality; and

a computer coupled to the first and second imagers, the computer to determine first coordinates of the plurality of markers relative to the first beam isocenter and determine second coordinates of the plurality of markers relative to the second beam isocenter.

54. The system of claim 53, wherein the first imager and the second imager are a same imager.